TITLE OF THE INVENTION

BEAM SCANNING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001]   This application claims the benefit of Korean Application No. 2002-53629, filed September 5, 2002, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0002]   The present invention relates to a beam scanning apparatus, and more particularly, to a beam scanning apparatus comprising a collimating lens consisting of one sheet of a spherical surface.

2. Description of the Related Art

[0003]   Generally, a laser printer prints an image on printing paper using a laser beam scanning apparatus. The beam scanning apparatus focuses light beams emitted from laser diodes onto a photosensitive drum according to an image signal, thereby forming a latent image on the photosensitive drum. The latent image is printed on the printing paper in a visible image.

[0004]   The beam scanning apparatus comprises a collimating lens for transforming the light beam emitted from the laser diode into a parallel beam or a convergent beam. In order to improve utilization of the light beam emitted from the laser diode, the collimating lens is designed to have a large numerical aperture (NA) which varies in value depending on a main scanning direction and a sub-scanning direction.

[0005]   Conventional collimating lenses use an aspherical surface lens made of a plastic so as to achieve a compact-sized and cost-saving beam scanning apparatus. However, conventional collimating lenses vary in refractivity with temperature changes in the beam scanning apparatus, causing the image spot to change.

[0006]   Also, conventional collimating lenses adjust a wavefront aberration through the combination of one sheet of a spherical surface lens and one sheet of an aspherical surface

lens or through one sheet of aspherical surface glass lens. However, while such collimating lenses are capable of adjusting the wavefront aberration, they are accompanied with increased fabrication cost.

SUMMARY OF THE INVENTION

[0007]   An aspect of the present invention is to provide a beam scanning apparatus comprising a collimating lens capable of preventing deteriorating printing quality caused by temperature changes and obtaining cost reduction effect.

[0008]   The above aspects and/or features of the present invention are achieved by a beam scanning apparatus including a collimating lens in which a beam emitted from a light source is transformed into at least one of a convergent beam and a parallel beam with respect to an optical axis and outputted towards a slit. The collimating lens being one sheet of a spherical surface lens satisfying:

$$-0.3 < \frac{R2}{R1} < -0.1$$

$$0.05 < \frac{d}{f} < 0.5$$

in which, *R1* denotes a curvature radius of a first surface of the collimating lens opposing the light source, *R2* denotes a curvature radius of a second surface of the collimating lens opposing the slit, *d* denotes a center thickness of the collimating lens, and *f* denotes a focal length from the collimating lens to the light source.

[0009]   The collimating lens has a positive refractive power, and is made of glass.

[0010]   The slit is formed in an elliptical shape having a larger diameter in a main scanning direction than in a sub-scanning direction.

[0011]   Additional and/or other aspects and advantages of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

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BRIEF DESCRIPTION OF THE DRAWINGS

[0012]   These and/or other the other aspects and advantages of the invention become apparent and more readily appreciated from the following description of the preferred embodiment taken in conjunction with reference to the accompanying drawings in which:

FIG. 1 is a view schematically showing a beam scanning apparatus comprising a collimating lens according to an embodiment of the present invention;

FIG. 2 is an enlarged cross sectional view of the collimating lens of FIG. 1;

FIG. 3A is a view showing light paths of the beams that pass through the collimating lens of FIG. 1 in a main scanning direction;

FIG. 3B is a view showing light paths of the beams that pass through the collimating lens of FIG. 1 in a sub-scanning direction;

FIG. 4 is a view showing an opening formed in the slit panel of FIG. 1 ; and

FIG. 5 is a graph showing an image beam diameter of the image spot formed on the photosensitive drum of the beam scanning apparatus of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013]   Reference will now be made in detail to the present preferred embodiment of the present invention, examples of which are illustrated in the accompanying drawings, wherein like reference numerals refer to the like elements throughout. The embodiments are described below in order to explain the present invention by referring to the figures.

[0014]   FIG. 1 is a view schematically showing a beam scanning apparatus comprising a collimating lens according to an embodiment of the present invention.

[0015]   Referring to FIG. 1, a beam scanning apparatus 100 includes a laser diode 110, a collimating lens 120, a slit panel 130, a cylinder lens 140, a polygon mirror 150, an f-theta lens 160, and a photosensitive drum 170.

[0016]   The laser diode 110 is a light source that emits light beams. The beams emitted from the laser diode 110 are transformed into parallel beams with respect to an optical axis or convergent beams through the collimating lens 120. The collimating lens 120 comprises one sheet of a spherical surface lens having a positive refractive power, and preferably, it is made of glass.

[0017]   FIG. 2 is an enlarged cross sectional view of the collimating lens 120 of FIG. 1.

[0018]   Referring to FIG. 2, the collimating lens 120 has a first surface 120a and a second surface 120b. The first surface 120a refers to an incident surface to which the beams emitted from the laser diode 110 enter, and the second surface 120b is an emergent surface from which the transformed incident beams, i.e., either the parallel beams or the convergent beams, emerge.

[0019]   The collimating lens 120 satisfies the following conditions:

$$-0.3 < \frac{R2}{R1} < -0.1$$

$$0.05 < \frac{d}{f} < 0.5$$

in which, "R1" denotes a curvature radius of the first surface 120a of the collimating lens 120 opposing the laser diode 110, and "R2" denotes a curvature radius of the second surface 120b of the collimating lens 120 opposing the slit panel 130, which will be described later.

[0020]   The center thickness, "d" denotes a center thickness of the collimating lens 120, i.e., it denotes a distance from a center of the first surface 120a to a center of the second surface 120b. The focal length "f" is a focal length from the collimating lens 120 to the laser diode 110. Generally, the focal length is calculated with a curvature and a thickness of a lens. The focal length as shown in the drawings indicates a general focal length and is variable.

[0021]   Among the beams passing through the collimating lens 120, beams with respect to a main scanning direction have light paths as illustrated in FIG. 3A, while the light paths of beams with respect to a sub-scanning direction are illustrated in FIG. 3B. The beams with respect to the main scanning direction and the sub-scanning direction are transformed into parallel beams with respect to an optical axis or convergent beams which are incident on the slit panel 130.

[0022]   The slit panel 130 opposes the second surface 120b of the collimating lens 120. As shown in FIG. 4, the slit panel 130 has a slit 130a which limits a size of a beam section of the beams passing through the collimating lens 120. Preferably, the slit 130a is formed in an elliptical shape that has a larger diameter in a main scanning direction than in a sub-scanning direction. Alternatively, the slit 130a may be formed in a circular shape.

[0023]   As the beams from the collimating lens 120 pass through the cylinder lens 140, the beams are transformed into linear shapes which are horizontal with respect to the sub-scanning direction. The polygon mirror 150 moves the horizontal linear beams from the cylinder lens 140 at a constant linear velocity for scanning. The polygon mirror 150 is provided with a motor (not shown) for rotating the polygon mirror 150 at a constant velocity.

[0024]   The f-theta (fθ) lens 160 has a constant refractivity with respect to the optical axis and refracts the beams of equal speed reflected from the polygon mirror 150 in the main scanning direction. Also, the f-theta (fθ) lens 160 adjusts aberration of the beams deflected from the polygon mirror 150 and guides the beams towards the photosensitive drum 170. Accordingly, image data is formed on the recording medium, i.e., on the photosensitive drum 170.

[0025]   Referring to table 1, dimensions of the optical elements of FIG. 1 will be described.

[0026]   Table 1 shows the dimensions of the laser diode (LD), the LD cover glass, and the collimating lens employed in the beam scanning apparatus of FIG. 1

Optical element	Curvature radius	Interplanar spacing	Refractivity
Laser Diode (LD)	Infinity	0.xxx	1.0
LD cover glass first surface	Infinity	0.25	1.xxx
LD cover glass second surface	Infinity	13.xxx	1.0
Collimating lens first surface	R1=36.xxx	3.xxx	1.xxx
Collimating lens second surface	R2=-9.xxx	3.xxx	1.0
Slit	Infinity	-	-

[0027]   In Table 1, the "interplanar spacing" refers to a distance between planes of the optical elements, and figures represented by 'xxx' range from 000 to 999. The focal length "f" of the collimating lens 120 is 15.xxx mm, the diameter of the slit 130a of the slit panel 130 in the main-scanning direction is 3.xxx mm, and the diameter of the slit 130a in the sub-scanning direction is 1.xxx mm.

[0028]   FIG. 5 is a graph showing an image beam diameter of an image that is formed on the photosensitive drum of the beam scanning apparatus of FIG. 1.

[0029]   Referring to FIG. 5, the position of an image on the A4 paper is represented with reference to the center being set as 0. The image beam diameter corresponds to the size of an image spot formed on the photosensitive drum 170 which is measured in the main scanning direction and the sub-scanning direction. The image beam diameter measured in the main scanning direction is represented by a solid line, and the image beam diameter measured in the sub-scanning direction is represented by a dotted line.

[0030]   As shown in FIG. 5, the beam scanning apparatus 100 having the dimensions of the table 1 and as described above offers performance which is applicable in a laser printer of ranging from 300dpi (dot per inch) to 600dpi.

[0031]   The beam scanning apparatus 100 according to the present invention uses the spherical collimating lens comprising one sheet of glass, thus achieving a compact-sized and cost-saving beam scanning apparatus. Also, the use of the collimating lens fabricated with glass prevents printing quality deterioration due to the temperature change.

[0032]   While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.